Contents
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Tsukuba Science City

Facilities
• National research facilities: 32 (1/3 in Japan)
• Private research facilities: 120
• National University: 1 (University of Tsukuba)

Researchers
• 2,000 researchers (10% of city population)
• 8,000 doctoral researchers
• 5,000 oversea researchers
### Regular staff members

<table>
<thead>
<tr>
<th>Position</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td>1</td>
</tr>
<tr>
<td>Trustee</td>
<td>6</td>
</tr>
<tr>
<td>Organizer</td>
<td>2</td>
</tr>
<tr>
<td>Professor</td>
<td>606</td>
</tr>
<tr>
<td>Assoc. Prof.</td>
<td>520</td>
</tr>
<tr>
<td>Lecturer</td>
<td>403</td>
</tr>
<tr>
<td>Asst. Prof.</td>
<td>128</td>
</tr>
<tr>
<td>Others</td>
<td>606</td>
</tr>
<tr>
<td>Admin. staff</td>
<td>1900</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4182</td>
</tr>
</tbody>
</table>

### Undergraduate:

- **10,190**

### Graduate:

- **6,556**

### Total:

- **16,746**

### International Students

- **From China:** 656
- **From Asia:** 1,235
- **Total:** 1,527

### Schools and Colleges (Undergraduate Courses)

#### School of Humanities and Culture
- College of Humanities
- College of Comparative Culture
- College of Japanese Language and Culture

#### School of Social and International Studies
- College of Social Sciences
- College of International Studies

#### School of Human Sciences
- College of Education
- College of Psychology
- College of Disability Sciences

#### School of Life and Environmental Sciences
- College of Biological Sciences
- College of Agro-Biological Resource Sciences
- College of Geoscience

#### School of Science and Engineering
- College of Mathematics
- College of Physics
- College of Chemistry
- **College of Engineering Sciences**
- College of Engineering Systems
- College of Policy and Planning Sciences

#### School of Informatics
- College of Information Science
- College of Media Arts, Science and Technology
- College of Knowledge and Library Sciences

#### School of Medicine and Medical Sciences
- School of Medicine
- School of Nursing
- School of Medical Sciences

#### School of Health and Physical Education

#### School of Art and Design
About the University Exchange Agreements and Current Achievements of the International Exchange Program with Germany

The University of Tsukuba cooperates with 11 German universities under the framework of student exchange programs. Joint research and academic exchange is available in numerous research fields.

List of Participating Schools

- University of Bonn University-level Agreement
- University of Bayreuth University-level Agreement
- Free University of Berlin University-level Agreement
- University of Stuttgart University-level Agreement
- University of Leipzig Department-level Agreement
- Ruhr-University Bochum Department-level Agreement
- Martin Luther University Halle-Wittenberg Department-level Agreement
- Brandenburg University of Technology, Cottbus Department-level Agreement
- Ludwig Maximilian University Munich Department-level Agreement
- Bielefeld University Department-level Agreement
- Augsburg University of Applied Sciences Department-level Agreement
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10.02.2012
Besuch der DAAD-Generalsekretärin in Tokyo


Deutscher Akademischer Austausch Dienst

http://www.tsukuba.ac.jp/topics/20120220142130.html

Partnership program between University of Tsukuba and DAAD
University of Tsukuba Acceleration Center (UTAC)

Pre-strategic project for UTAC
University of Tsukuba supports UTAC for i) establishing active research communities in Tsukuba area and ii) scientific relationships between UT and foreign research groups.

12MV Pelletron tandem accelerator
- Ion implantation
- Nano scale Material design
- Ion scattering (RBS)
- AMS (Cl-36)
- Isotope analysis
- ERCS

1 MV tandemron accelerator
- RBS/ERDA
- PIXE

Facilities using RI
- Positron annihilation
- Mössbauer spectroscopy
Akira Uedono
Division of Applied Physics, Faculty of Pure and Applied Science, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan

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Doppler broadening of the annihilation $\gamma$-rays

Due to the energy and momentum conservations, the energy of $\gamma$ rays is broadened due to the electron momentum, $p_L$ (parallel to the direction of the $\gamma$ rays).

\[ E_\gamma = m_0 c^2 \pm \Delta E_\gamma = m_0 c^2 \pm c p_L / 2 \]

Energy of $\gamma$-rays

(1 a.u. = 7.297 mrad = 1.86 keV)
A freely diffusing $e^+$ may be localized in an open space because of the Coulomb repulsion from ion cores.

Electron density in vacancies is lower than that in interstitial site.

Increase in the positron lifetime
Detection of vacancy-type defects using PAS

Change in electron momentum due to coupling with impurities.

Coulomb attraction from negatively charged \( V \).

Coulomb repulsion from positively charged \( V \).

Positron trapping fraction of defects, \( F_d \), for \( V_{Ga} \) in GaN.
Monoenergetic positron beam in University of Tsukuba

Source ($^{22}\text{Na}$) → Sample

Beam monitor → Sample chamber

Ge detector → Positron beam ($\phi 3$-10 mm)
Akira Uedono
Division of Applied Physics, Faculty of Pure and Applied Science, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan

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Vacancy-type defects in Cu(In,Ga)Se$_2$ probed by positron annihilation

Institute of Applied Physics, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan

A. Yamada, S. Ishizuka, K. Matsubara, and S. Niki
Research Center for Photovoltaics, National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki 305-8568, Japan

S. Ishibashi
Nanosystem Research Institute (NRI) “RICS”, National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki 305-8568, Japan
Cu(In,Ga)Se$_2$ (CIGS) is the most promising materials to realize high-efficiency, low cost thin film solar cell, due to its high optical absorption as direct gap material and cost effective growth procedure.

- Complex solar cell structures
- Quaternary material
- Difficulty in the growth control (presence of multi-phase)

The efficiency is behind the theoretical prediction of 31% expecting for CIGS with $E_g=1.4$ eV.

S. Niki et al., SEE 2006 A041.
Knowledge about defects and their correlation to the material properties is important to achieve conversion efficiency beyond the current limit.
Sample preparation
AIST (Niki group) & University of Tsukuba (Akimoto lab.)

Mo deposition on soda lime glass substrate

Three-stage evaporation process using MBE (see next figure)

CdS layer deposition (to avoid oxidation)

Electron probe micro analyzer (EPMA) was performed to determine the material composition of the films in relation to the interpretation of results obtained through PAS technique.
Impact of Cu/III (=In+Ga) ratio on S for CGS (Se=5.8×10^{-3} Pa)

- Introduction of vacancy-type defects is suppressed with increasing Cu/III ratio.
- Conversion efficiency increased with increasing Cu/III ratio.
The $(S, W)$ value approaches the defect free $(S, W)$ value along the line connecting complexes between $V_{Cu}$ and $V_{Se}$.

The $(S, W)$ values observed for CGS are far from those for monovacancies.

The defects species detected by positron annihilation is vacancy clusters.

The major defects controlled by changing Cu/III ratio is the complexes between $V_{Cu}$ and $V_{Se}$.

$\tau_1 = 300-330 \text{ ps} \ (\sim 95\%)$

(S/N was not good, should be confirmed)
Lot of problems we should solve.

Too many defects?
Inhomogeneity?
Single crystal?
Grain effect?

Those open questions would be good, because if I could solve everything by myself, I do not need collaboration.